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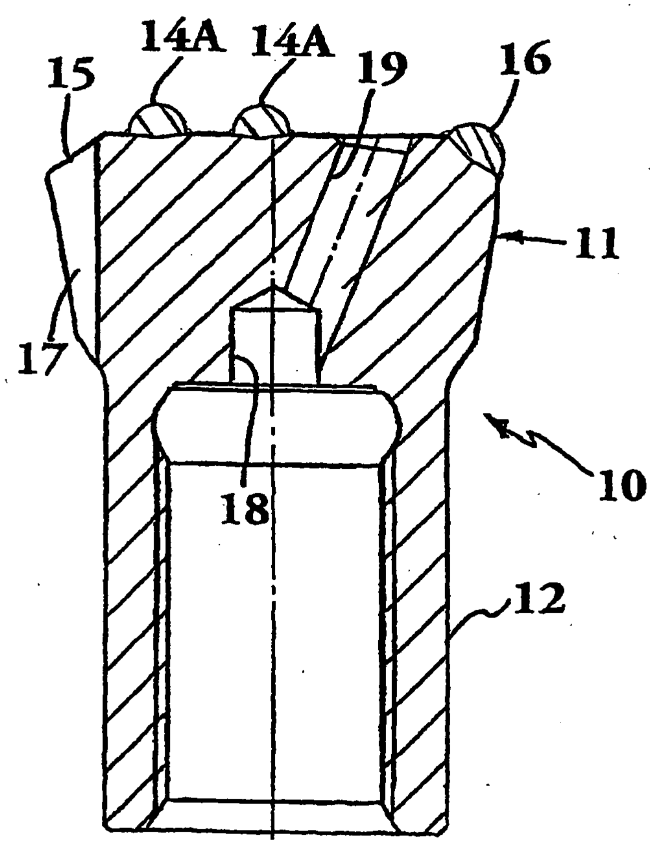
(54) Title: A METHOD FOR THE MANUFACTURING OF A DRILL BIT FOR PERCUSSIVE ROCK DRILLING AND A ROCK DRILL BIT AND BUTTONS THEREFOR



(57) Abstract: The present invention relates to a method for the manufacturing of drill bits for percussive rock drilling and a rock drill bit (10) and a button (14A). The rock drill bit includes a head portion (11) with a forward surface (13; 15), which has a number of buttons (16) provided in a peripheral wreath, and a number front buttons (14A) placed inside the peripheral buttons (16). At least one of said buttons has a diameter (D) and a height (H). The button (14A) is welded to an essentially flat part of the forward surface. The button is metallurgically bound to the forward surface (13, 15) and the following formula applies: H/D<1.2.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A METHOD FOR THE MANUFACTURING OF A DRILL BIT FOR PERCUSSIVE ROCK DRILLING AND A ROCK DRILL BIT AND BUTTONS THEREFOR

Background of the invention

The present invention relates to a method for the manufacturing of a drill bit for percussive rock drilling and a rock drill bit and a button in accordance with the preambles of the appended independent claims.

Prior art

A rock drill bit is intended to crush rocks. This is achieved by generating impacts or shock waves at a drilling machine and transferring those via a rod to the end surface where the drill bit is secured. The crushing is achieved by so called buttons or chisels of hard metal, which are positioned in the front of the steely drill body. The buttons and the chisels are submitted to high strains during impacting. Today the buttons or the chisels are secured through pressing into drilled holes or through soldering in milled grooves. In drilled hole buttons are held by friction to the bore wall or, in case of chisel bits, with the assistance of brazing material. At brazing a material often is applied having relatively low strength and which melts at low temperature, which is limiting for the strength of the joint. The bending moment on a button is received by the bore wall in the drill body. These parameters makes that relatively deep holes are required in the drill body, that is holes in the magnitude of 5-20 mm, depending of the dimensions of the hard metal and therefor the geometry of the drill body must be oversized. Since the volume of the drill body is limited also the number of buttons and their possible positions become limited. Thereby the options for positioning of flush channels in the drill body become limited. In addition, only a smaller part of the hard metal of the button is used for machining. In case the buttons are diamond coated the heat from brazing can damage the diamond layer.

Objects of the invention

One object of the present invention is to provide a method for the manufacturing of drill bits for percussive rock drilling and a rock drill bit and a button, which counteract the above-captioned drawbacks.

Another object of the present invention is to provide a rock drill bit, which allows great opportunities regarding cavities in the drill body.

Still another object of the present invention is to provide a button, which enables a simple mounting to the drill body.

Still another object of the present invention is to provide a method for the manufacturing of drill bits for percussive rock drilling, which is fast and efficient.

Brief description of the drawings

These and other objects have been achieved by means of a method for the manufacturing of drill bits for percussive rock drilling and a rock drill bit and a button, which have obtained the features according to the characteristics of the appended independent claims with reference to the drawings. Fig. 1 shows a rock drill bit according to the present invention in a perspective view. Fig. 2A shows the drill bit in a cross-section according to line II-II in Fig. 1. Fig. 2B shows the drill bit in an enlarged cross-section according to Fig. 2A. Figs. 3A-3G schematically show a process according to the present invention with spot welding of a button to a drill body. Fig. 4 shows a button according to the present invention in a side view. Figs. 5A-5G schematically show an alternative process according to the present invention with spot welding of a button to a drill body. Figs. 6-10 show alternative embodiments of buttons according to the present invention in side views.

Detailed description of the invention

In Figs. 1, 2A and 2B is shown a rock drill bit 10, which in a conventional manner comprises a substantially cylindrical head portion 11 and a thinner shank 12. The head portion 11 has a front surface depicted by 13 on which a number of front buttons 14A are assembled. A surface portion 15 between the front surface 13 and the periphery of the head portion is conically shaped. A number of first buttons 16 are arranged on this conical surface portion 15 in a peripheral wreath

on the head portion. The front buttons 14A and the peripheral buttons 16 may be identical. Parts of these first buttons 16 extend in this case somewhat outside the periphery of the head portion such to drill a hole, which has a bigger diameter than the head portion. In areas between adjacent peripheral buttons 16 recesses 17 are provided through which flush medium can pass. Such as is evident from Fig. 2A a main channel 18 for flush medium is provided internally in the drill bit. This main channel surpasses at its forward end in a number of branch channels 19, which terminate in said recesses 17 and in the front surface. At least one of the front buttons 14A is provided close to the orifice of the branch channel and basically axially in front of the branch channel. The flush medium is in practice water or air. The shape of the button end may vary considerably. It can thus be semi-spherical, conical, ballistic or semi-ballistic.

The buttons are made from wear resistant hard metal, such as wolfram carbide and cobalt pressed together whereafter the formed body is sintered. Since hard metal is an expensive material the cost of the drill bit would sink if the hard metal portion that normally is pressed downwards into the hole in the steel body could be eliminated. The cost for manufacturing should also be lower if hole drilling did not have to be performed. In the present invention the hard metal is directly secured to the steel body by welding. Welding means that the surfaces are heated and are pressed together such that a so-called metallurgical bond with high strength is obtained between the two materials.

A problem at welding of hard metal is the high carbon content. The carbon content in the steel closest to the joint will increase at melting, with the risk of brittleness. To limit this the welding time is chosen short, which puts special demands on the choice of welding method.

A suitable method where specifically short welding time is characteristic is the capacitor discharge spot welding, which is illustrated in Figs. 3A-3G. The method means that the button 14A and the work piece is connected to a circuit in which a capacitor pack, not shown, is discharged. A specially formed tip 22 in the button makes the current very high locally and an electric arc 43 arises. This electric arc vaporizes the tip and melts the surfaces. The button is pressed or pushed against the work piece wherein the melt solidifies and a metallurgical or

chemical bond arises. The course of welding is very fast, in the magnitude of 1-5 milliseconds (ms), and it is shown in Figs. 3A-3G. Welding can also be made without a gap, i.e. without step A in the figure, and then the welding time becomes somewhat longer but no longer than 1 second. The method according to the present invention with reference to Figs. 3A-3G consequently comprises: A- The capacitor pack is charged and the button 14A is accelerated towards the work piece 13. B- The tip 22 engages the work piece 13 and will short cut the capacitor pack. C- The tip 22 is vaporized. D- An electric arc 43 is formed between the button and the work piece. E- The electric arc melts the surface layer of both materials. F- The button impacts into the work piece and welds the materials. G- The melt layers immediately solidify in an essentially conical weld joint 41 and the welding is finished. In Figs. 2A and 2B is illustrated that the solidified material, mostly steel, formed an upset 40 about each button. The thickness of the weld joint lies within the interval of 1 - 300 micrometer (μm).

The button 14A, which has been adapted to the method according to the present invention is shown in Fig. 4. The button of hard metal has a substantially cylindrical shank portion 23 and a semi-spherical working end 24. The button has a center axis CL. The end surface defines a radius R, the center of which lies in a plane P. The shank portion 23 has a diameter D. The tip 22 extends symmetrically about the central axis CL from a lower side 25A of the button. The lower side 25A is substantially conical in shape with an internal cone angle, which is from 150° to less than 180°, preferably about 174°. The tip has a diameter D about 0.75 mm. The shank portion 23 has a height h1 from a transition 26 to the lower side 25A to the plane P that is from 0.2 to 2.8 mm. The tip 22 and the lower side 25A have a height h2 about 1.2 mm measured from the transition 26. The height H of the button constitutes the part of the button which is intended to protrude from the front surface and the height is defined from transition 26 to the top of the button, that is H=h1 + R, and is from 3.3 to 10.7 mm. Suitable values regarding button dimensions for buttons according to the present invention with the most common button diameters for percussive rock drilling has been listed in the table below. When applicable, the unit is millimeter.

Diameter D	Protrusion H	H-h1	Cyl. part h1	H/D
7	3,32	2,2	1,12	0,47
7	4,87	3,9	0,97	0,70
8	3,97	2,6	1,37	0,50
8	4,77	4,5	0,27	0,60
9	4,25	2,8	1,45	0,47
9	6,25	5	1,25	0,69
10	4,85	3,2	1,65	0,49
10	6,45	5,8	0,65	0,65
11	4,85	3,6	1,25	0,44
11	7,45	6,3	1,15	0,68
12	5,02	3,9	1,12	0,42
12	7,72	7,1	0,62	0,64
13	5,61	4,1	1,51	0,43
13	8,71	7,5	1,21	0,67
14	6,41	4,5	1,91	0,46
14	9,31	8	1,31	0,67
16	7,86	5,1	2,76	0,49
16	10,66	9,3	1,36	0,67
max	10,66	9,3	2,76	0,70
min	3,32	2,2	0,27	0,42

The H/D ratio is about 0.4 to 0.7 as is evident from the table, but is definitively smaller than 1.2, i.e. H/D<1.2. If the entire length H + h2 of the button is compared to the length of a conventional button it will show that the length of the button according to the present invention is about only a third of the length of the conventional button.

Welding may alternatively be made through resistance welding, which is illustrated in Figs. 5A-5G. The welding may be of the type where heat is

generated by means of current, which is conducted through two surfaces under pressure. Especially suitable are two procedures, which resemble capacitor discharge spot welding, namely the so-called SC (Short Cycle) and ARC methods. The difference compared to capacitor discharge spot welding is that a transformer current source is used and the button has a wholly conical lower side instead of a tip. The button is in contact with the work piece from the start but is lifted up a short distance simultaneous as the current is turned on. Thereby an electric arc is formed which melts the surfaces in the manner as described above. Finally the button is pushed downwards into the work piece and the weld is formed. The welding time, which is somewhat longer than at capacitor discharge spot welding, is controlled through regulation of the time between the ignition of the electric arc and when the button is pushed downwards. The SC method is illustrated in Figs. 5A-5F. The SC method according to the present invention with reference to Figs. 5A-5F consequently comprises: A- The button is initially in contact with the work piece. B- Simultaneous as the current is turned on the button is lifted from the work piece whereby an electric arc is formed. C- The electric arc 43 is formed between the button and the work piece. D- The electric arc melts the surface layer of both materials. E- The button impacts into the work piece and welds the materials. G- The melt layers immediately solidify and the weld joint 41 is finished. The welding time for the SC method seldom exceeds 20 ms.

The button 14B that has been adapted to the alternative method according to the present invention is shown in Fig. 6. The difference between the button 14B and the above-described button 14A is that the button 14B does not have a tip and therefore the lower side 25b consists of a wholly conical surface with an inner cone angle about 166°. An important common feature for both buttons is that they have a lower side which smallest diameter is smaller than the diameter D of the button, i.e. a substantially conical weld joint 41 is obtained. Thereby is compensated for more melting of the steel which normally arise at the mid section of the button.

The ARC method is used for bigger dimensions and functions in the same manner as the SC method. Since longer welding times are used the weld

in this case is protected by means of a ceramic ring or gas. The welding time depends on the diameter, for example 200-400 ms for a button with a diameter of 10 mm, but seldom or never exceeds 1 second.

The hard metal can be covered with a layer of nickel or cobalt before welding such to increase strength of the joint.

Example 1: Hard metal buttons with a diameter of Ø 7 mm were welded by means of capacitor discharge spot welding to a steel body in a tempered steel of the TYPE SS2244. The hard metal buttons were shaped according to Fig. 4. At the welding a lifting height of 1 mm was used, the voltage 160 V and the pressure 50 N were applied during the welding time of 3 ms. Through metallographical investigation was authenticated that a metallurgical bond was obtained between the steel body and the hard metal buttons.

Example 2: Hard metal buttons with a diameter of Ø 7 mm were welded by means of the SC method to a steel body in a tempered steel of the TYPE SS2244. The hard metal buttons were shaped according to Fig. 6. At the welding a lifting height of 1 mm was used, the voltage 550 V was applied during the welding time of 20 ms. Through metallographical investigation was authenticated that a metallurgical bond was obtained between the steel body and the hard metal.

An additional advantage with the methods according to the present invention is that more buttons can be positioned on the front surface of the drill bit such to obtain better machining, i.e. a higher penetration rate. The buttons can be secured by welding also on the smooth, conical surface portion 15. The short welding time enables welding also of diamond coated buttons. Each button 14A, 14B according to the present invention, which is to be welded, is shorter than a corresponding conventional button, and thus expensive hard metal is saved. In addition, there is no need for preparation of the weld joint on the head portion 11. The button 14A, 14B is not intended to be rotated at welding and can therefore alternatively be asymmetrically shaped and thus needs no driving surfaces. In the asymmetric case in the formula in the claims "D" depicts the biggest width of the asymmetrical button. The height h1 of the shank of the

button may be 0 to 15 mm, i.e. its working surface 24 may connect for example directly to the lower side 25A, 25B.

Fig. 7 shows a button 14C according to the present invention, with a ballistic basic form, which is somewhat more aggressive than the above-described buttons are. Fig. 8 shows a button 14D according to the present invention, with a conical basic form, which is still more aggressive than the above-described buttons are. Fig. 9 shows a button 14E according to the present invention such as mentioned above, with an asymmetrical, essentially conical basic form. Such as evident from Fig. 10 the button 14F according to the present invention is formed with a shoulder and an intermediate concave portion. The shoulder protects the surrounding steel in the head portion 11 from wear and gives bigger welded surface.

Alternatively the buttons 14A-14f may be performed in material similar to the type of hard metal which is described in US-A-5 286 549 wherein is shown hard metal bodies, which contain WC and a binder based on at least one of Co, Fe and Ni and which includes a soft core of hard metal surrounded by a harder surface zone of hard metal. It is understood that the buttons 14C-14F can be provided with a tip 22 to enable capacitor discharge spot welding of these.

The present invention consequently brings about a rock drill bit for percussive rock drilling which allows a large degree of freedom regarding cavities such as flush channels in the drill body. In addition, button geometries are provided and a method that enables a simple and quick mounting of the button to the drill body, which in turn provides material technical advantages.

The present invention is not limited to the exemplified embodiments but may be modified within the scope of the claims.

Claims

1. A rock drill bit for percussive drilling, including a bit body (11) with a forward surface (13;15), which has a number of buttons (16) provided in a peripheral wreath, and a number of front buttons (14A-14f) positioned inside the peripheral buttons (16), at least one of said buttons having a diameter (D) and a height (H), characterized in that said at least one button (14A-14F) is welded to an essentially flat part of the forward surface and in that the button is metallurgically bound to the forward surface (13,15) and that the following formula applies: H/D<1.2.

2. A button of hard metal for percussive drilling, which has an operative working end (24) and which may have a shank (23), said button (14A-14F) shall be provided on a forward surface (13;15) of a rock drill bit (10), said button has a center axis (CL), a diameter (D) and a height (H), said button having a lower side (25A;25B),
characterized in that the lower side (25A;25b) is at least partly conical to be secured by means of spot welding to the forward surface (13,15) and in that the following formula applies: H/D<1.2.

3. The button according to claim 2, wherein the lower side (25A) comprises a tip (22), which extends symmetrically about the central axis (CL) from the lower side (25A) of the button.

4. The button according to claim 2, wherein the lower side (25A) is substantially conically shaped and has an internal cone angle which is from 150° to less than 180°.

5. The button according to anyone of the preceding claims, wherein the height (h1) of the shank is 0 to 15 mm, preferably 0.2 to 2.8 mm.

6. A method for manufacturing a rock drill bit for percussive drilling, said rock drill bit (10) comprising a body with a head portion (11) which has a forward surface (13;15), which surface has a number of buttons (16) provided in a peripheral wreath, and a number front buttons (14A-14f) placed inside the peripheral buttons (16),

c h a r a c t e r i z e d i n that the method comprises the following steps:

- providing a button, the height (H) of which relates to its diameter (D) as H/D<1.2,
- providing a source of current with two electric poles,
- connecting the body to one pole and a button (14A-14F) to the other pole and,
- bringing together the forward surface of the body and the button such that an electric arc (43) forms between the forward surface and the button,
- making sure that the electric arc melts the surface layer of both the forward surface and the button,
- pressing the button against the forward surface,
- making sure that the melt layers solidifies and
- repeating said steps for each button until the rock drill bit has a desired number of welded buttons.

7. Method according to claim 6, wherein the source of current is a capacitor pack intended to be charged before the welding and wherein the button is accelerated towards the work piece such that a tip (22) on a lower side (25A) of the button (14A) engages with the forward surface (13;15) and thereby short-circuits the capacitor pack such that the tip becomes vaporized.

8. Method according to claim 6, wherein the button (14B) initially is held in contact with the forward surface (13;15) simultaneous as current is turned on whereafter the button is lifted up from the forward surface whereby an electric arc (43) is formed.

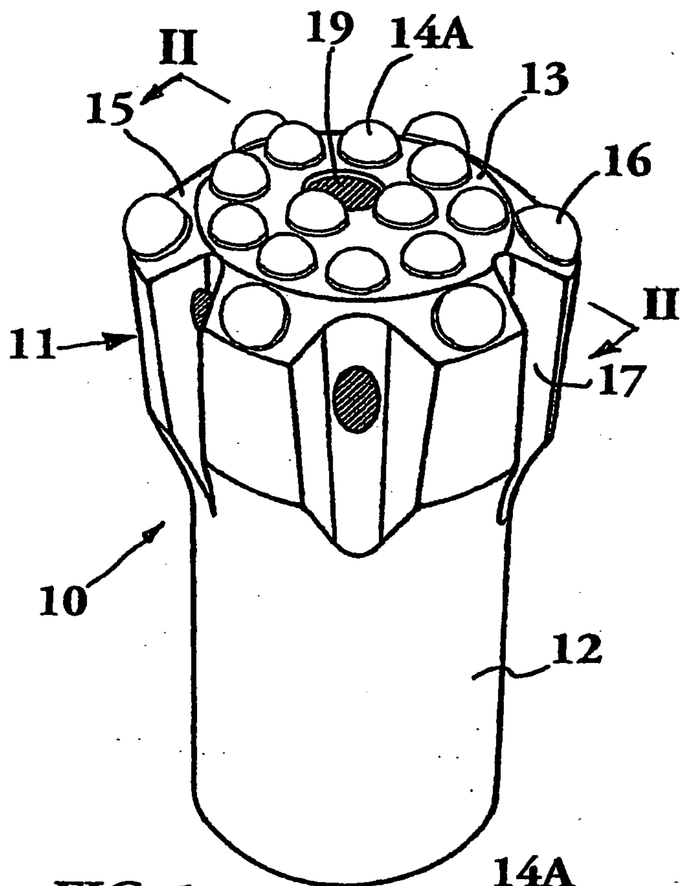

FIG. 1

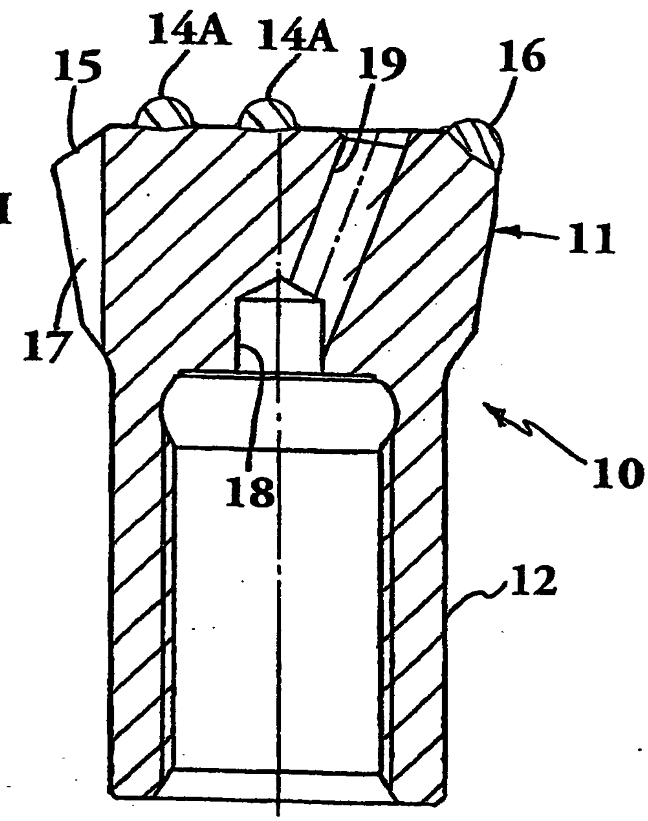

FIG. 2A

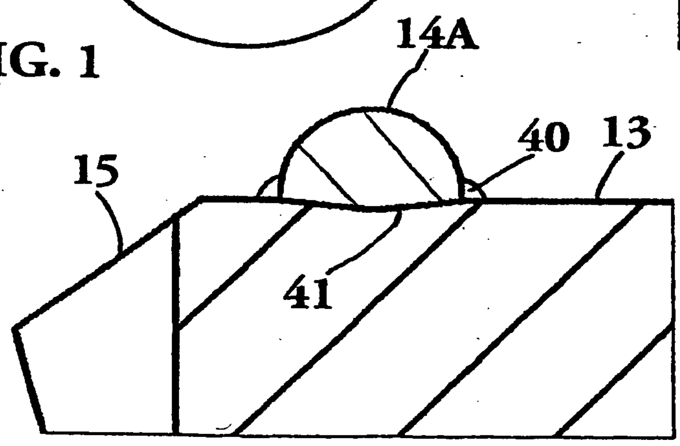

FIG. 2B

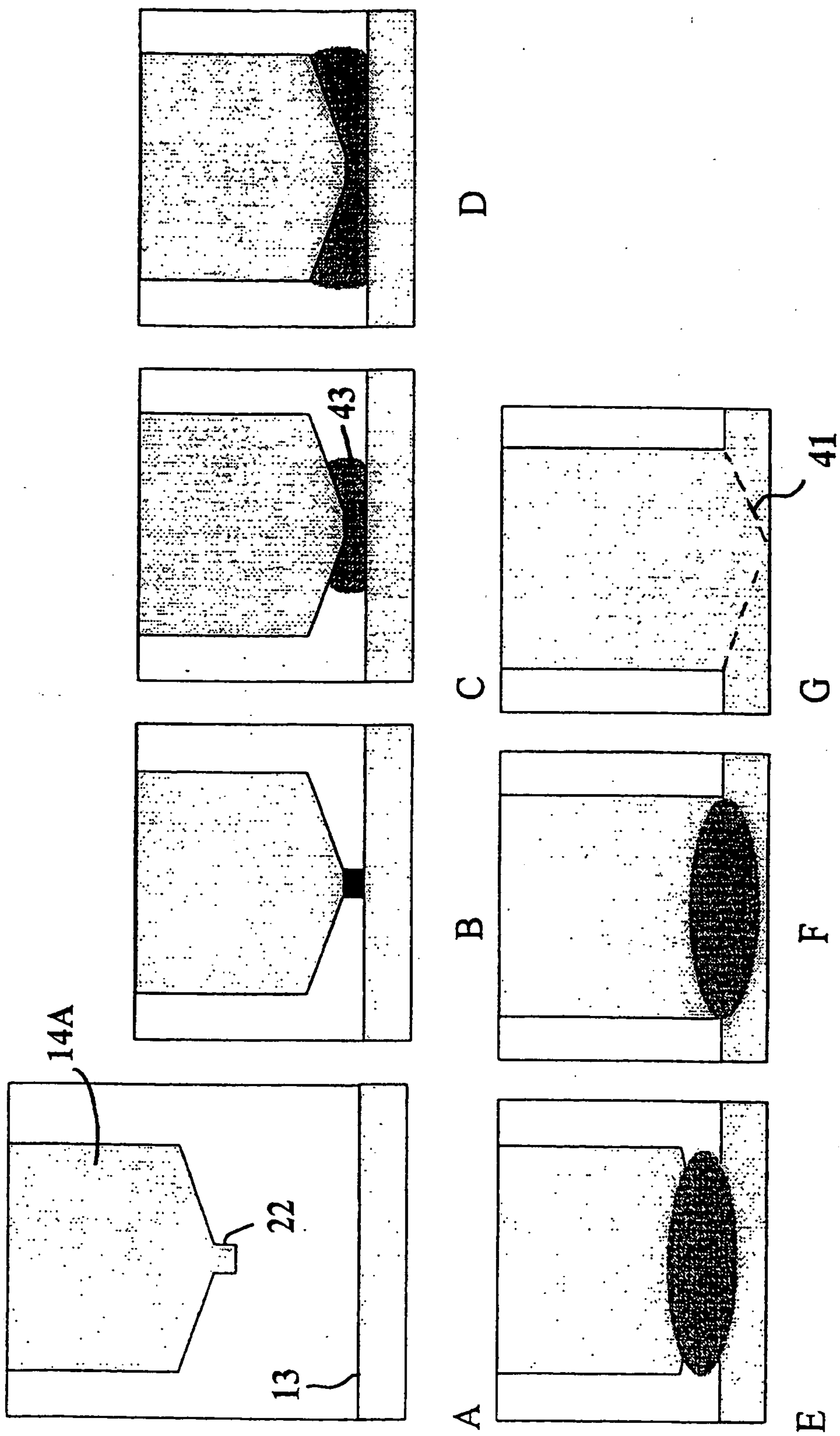

FIG. 3

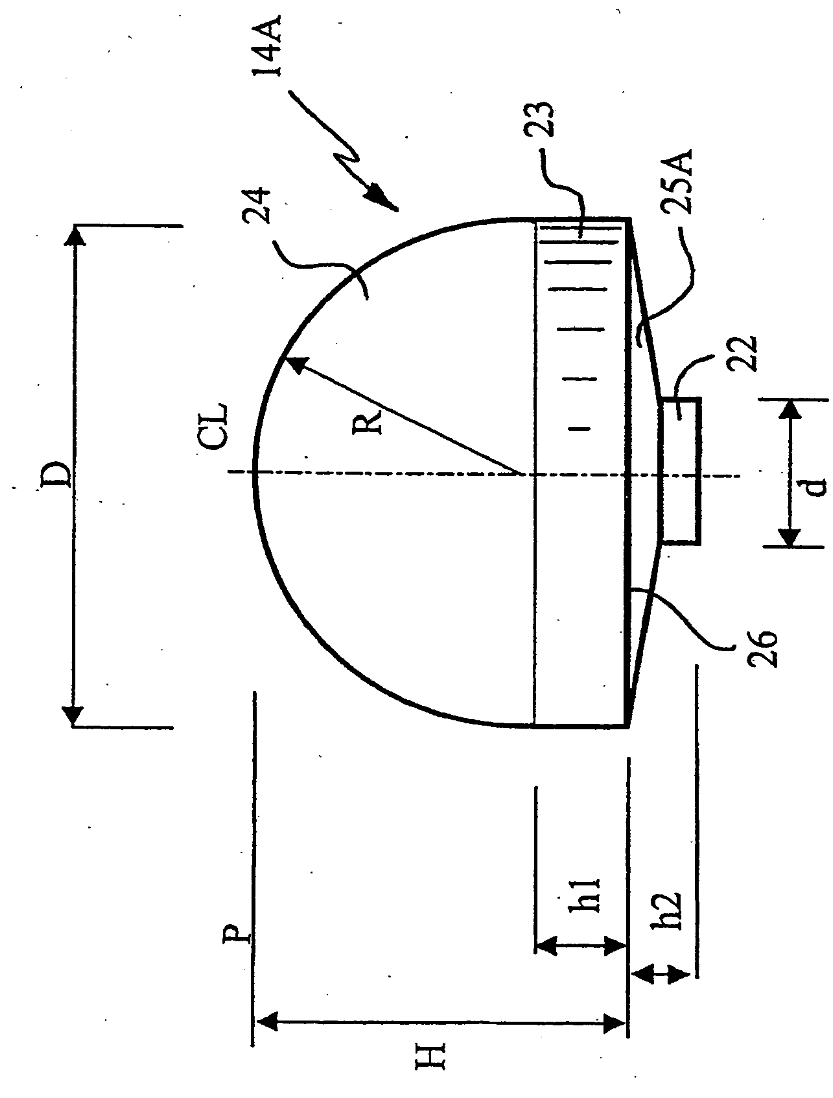

FIG. 4

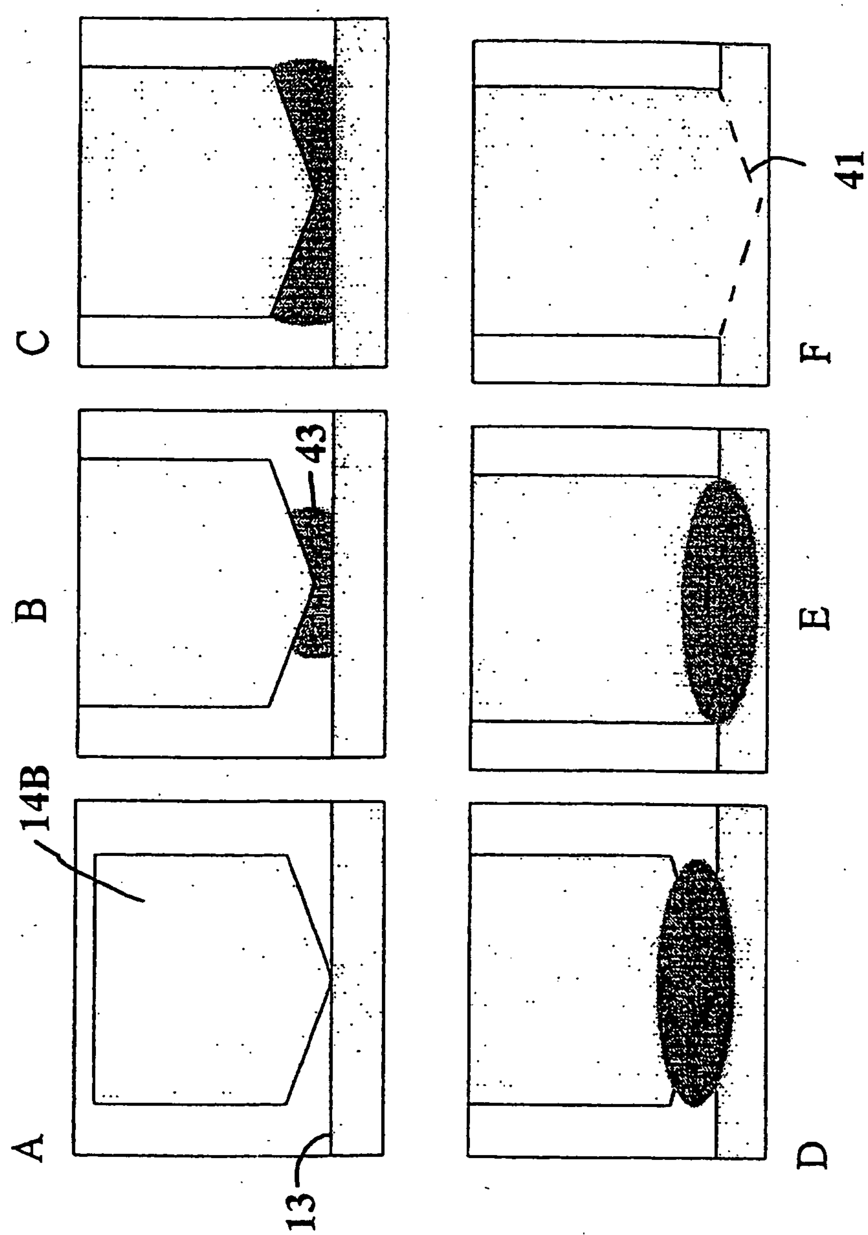

FIG. 5

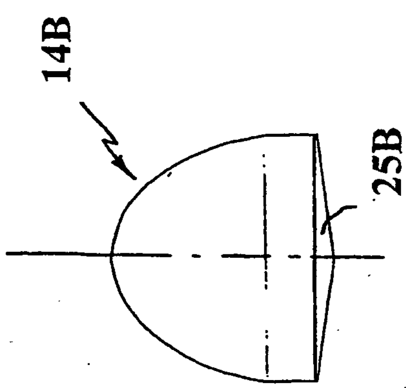

FIG. 6

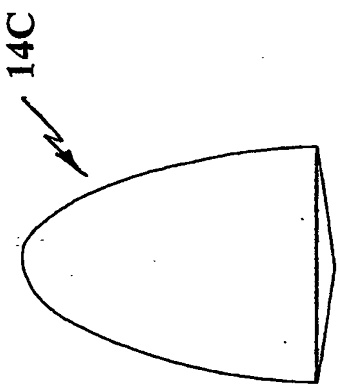

FIG. 7

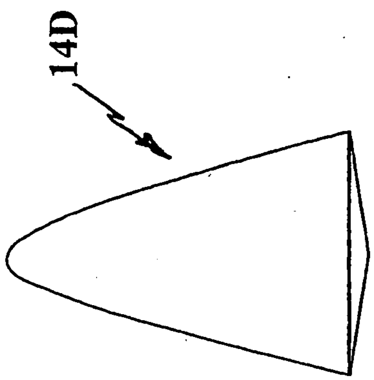

FIG. 8

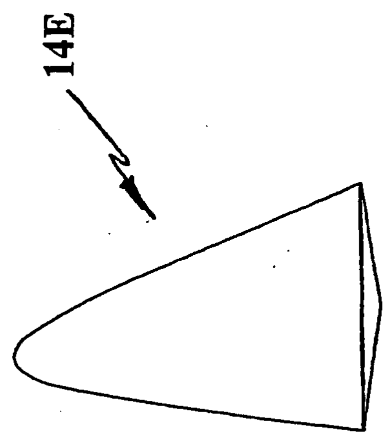

FIG. 9

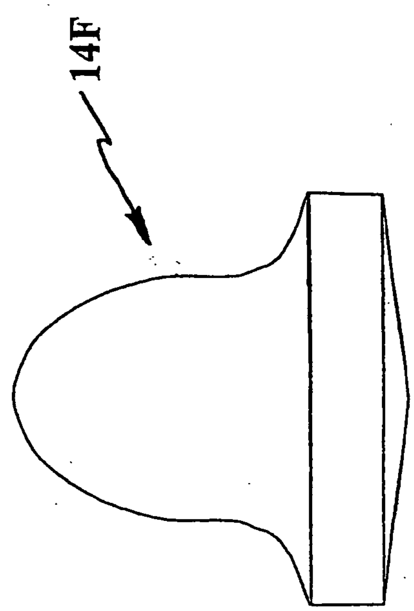

FIG. 10